dangers that lie in the way of a too early introduction to too difficult matter. It is by no means a bad specimen of the way in which a scientific lecture is reproduced in the young student's mind; it is, on the contrary, a remarkably favorable one. A great part of the information conveyed has been properly assimilated, and made a part of the real furniture of the boy's mind; and it is reproduced with vigor and originality. It is very different from a mere committing to memory of hard names, which might have been the effect; but it has still important warnings to convey.

The wise teacher will always take the examination-papers of her brighter pupils as a sure and searching test of the value of the instruction which she has endeavored to give. There are three plain and easy lessons which she will derive from the one before us. She will shut her eyes to the unchildlike and uncanny air of 'smartness,' — the *gamin*-like quality which is attractive in a French novel, but nauseating in real life in America; and she will attend only to the scientific ideas expressed. She will draw two morals for her next lesson on bones, and one for her scientific teaching in general. She will see that the connection between bones and the general idea of motion is far too difficult to be given to a young child. Hereafter she will tie strings or elastic bands to sticks, perhaps, and show how particular movements may be effected; but she will omit to give principles in regard to the production of motion in general. She will also refrain from calling the bony outside of certain animals a skeleton. Such fanciful extensions of the meaning of popular names will do for older children; but older children can also learn to say 'exoskeleton' and 'endoskeleton,' and the content of a name in a child's mind is a matter which is no more to be trifled with than the logical sequence of ideas. In the third place, the teacher will notice — what she has often noticed before — that it is a hazardous thing to supply a young child with reasons. Facts may be safely given in any amount, so long as they are simple, and such as he could find out for himself if put in the proper circumstances; but reasons should be given as sparingly as possible. He has not yet any means of knowing what kind of a thing a reason is; and it is of the utmost consequence that he should not be hopelessly set adrift on this subject. Probably the most characteristic of all the qualities of the untrained mind is the facility with which it is able to give a reason for every thing that happens.

Christine Ladd Franklin.

THE RESULTS OF THE KRAKATOA ERUPTION.[1]

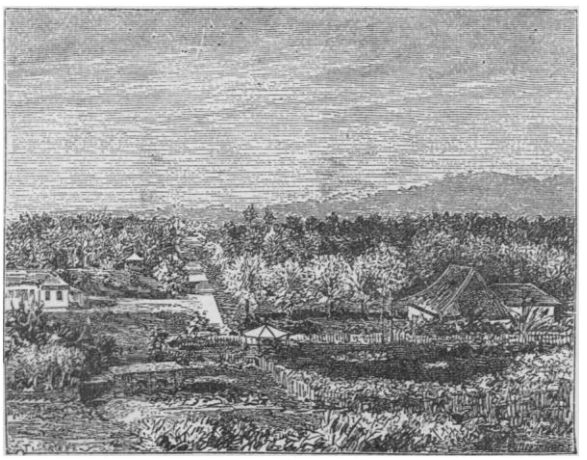
In the spring of 1884, Messrs. René Bréon and Korthals sailed from France, under instruction from the minister of public instruction, to explore the island of Krakatoa, and study the effects of the great eruption of Aug. 27, 1883. When they arrived at the bay of Bantam, they gradually passed from islands thickly covered with a tropical vegetation, to those burned and devastated by the rain of cinders and the tidal-waves. Upon Cape St. Nicolas, the cocoa-trees were parched and yellow; and the only signs of vegetable life were the young shoots of the year, which were springing from the tops of the half-dead trees. On the coast of Bantam, the shock of the wave had broken off a reef twenty to twenty-five metres high, and ingulfed it beneath the sea. The wave which rushed with such force upon this coast destroyed the forest for a distance of three hundred or four hundred metres inland, leaving nothing standing except the great Ficus religiosa, which stretched their dry and barkless stems toward the heavens. But already nature was repairing the damage, and the powerful tropical vegetation was springing up amid the ruins.

In the bay of Lampong, there were signs of a more powerful shock. A band of land devastated by the tidal-wave rises to a height of twenty-five metres above sea-level, and the destruction begun by the sea was still farther extended inland by the rain of burning cinders which were thrown from the volcano. They proceeded up the bay, and anchored in front of the site of Telok-Betoeng, which was destroyed by the tidal-wave. It was situated on a plain but a few feet above sea-level, and was the home of a number of European merchants and dignitaries, in addition to the Malay population. The place where the town stood is now a marsh, covered with cinders, and incumbered with trunks of trees, beams, and *débris* of all kinds. A little back of this, on the sides of a hill, some European houses, and a native hut, still remain, — thanks to their position above the reach of the waves. A small river flows to the sea through the old site of the village; and near this stream, in a dense forest three kilometers from the seashore, there is a native fishing-vessel, lying where it was tossed by the inrushing waters. Near by there are others; and, a few hundred metres from there, on a bend of the stream, a large steamer, the Barrow, forms a bridge from bank to bank. It is reported that the water rose to a height of three hundred metres, which cannot be a great exaggeration of the facts.

Leaving Telok-Betoeng, they proceeded to Sebuku, one of the group of islands to which Krakatoa belongs. This is not a central volcanic cone like its neighbors Sebesie and Krakatoa, but rather a fragment of land detached from Sebesie or Sumatra by some ancient eruption. The forests on this island are much more confused than those on the border of the bay of Lampong, and one can readily see that the centre of volcanic activity is being approached. Con-

[1] Condensed from *La nature*.

tinuing the voyage, the travellers arrived at the island of Sebesie, and here the destruction was complete, — hardly a bit of herbage, hardly a trace of life, remained. A coat of gray cinders mixed with pumice,



TELOK-BETOENG BEFORE THE ERUPTION.

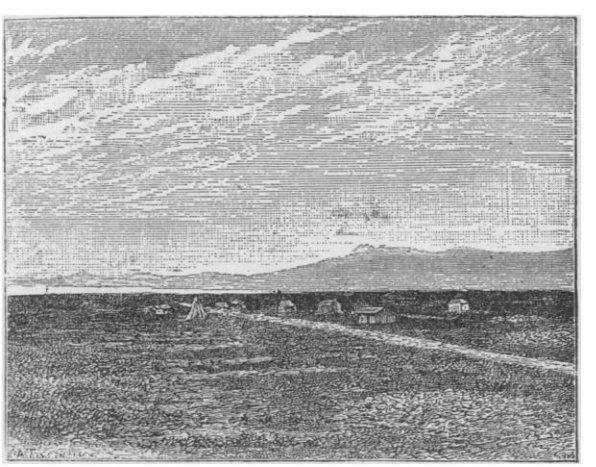
and fragments of a greenish, glass-like substance, covers this island to a depth of ten metres. From a distance, the sides of the hills are seen to be furrowed by ravines; and, upon nearer approach, it is found that the torrents of rain that fell during the last monsoon have washed out deep furrows in the light layers of cinders. At the bottom of one of these ravines, in the midst of the remains of houses and household utensils, fifty skeletons were found lying about. Sebesie was inhabited by two thousand Malays; and the unfortunate natives, unable to escape the hail of burning projectiles, resigned themselves to their fate, and gathered together to invoke divine protection by means of their Koran, which was found in many places scorched and torn among the ruins.

The commission soon left this island, and directed their course towards Krakatoa, the object of their visit. On the way, they passed the place where Steers and Calmayer islands had been formed in shallow water by the accumulation of ejected matter; but, to their surprise, they found that no traces of these islands remained. Their disappearance is easily explained, for so light a substance would be easily removed by the waves. The depression between these two ephemeral islands is much shallower than before.

Passing on through patches of floating pumice, the steamer neared Krakatoa, upon which could be seen undulating lines similar to those on Sebesie. The north side of the island is split from east to west, one-half having been swallowed up in the sea. The cliff thus exposed to view from the sea is composed of various volcanic strata, intersected by many-colored veins of different sizes, which are the vents by which the subterranean fires have forced the molten rock to the surface to build the cone. A light smoke hung above the cone, and from the distance it looked as if volcanic activity had not yet ceased.

Upon nearing the shore, the cause was plainly seen. Stones of all sizes were falling from the cliff, sending a spray into the air, while the finer dust floated upward, and gathered in a cloud about the summit of the volcano. This continual fall of rocks is the result of the expansion caused by the rays of the sun as they strike upon the black walls of the cliff. This is proved by the fact, that the fall was greatest when the rays shone full upon the cliff, and nearly ceased in the evening. At the base of this cliff the sounding-line showed a depth varying from fifty to three hundred metres in a square surface of thirty-three kilometres, which once was elevated above the sea. The only remnant of this ingulfed portion of the island is a rock about a mile to the north of the cliff. Before the eruption, the island of Krakatoa was made up of three cones, — Danan and Perboewatan, which disappeared with the northern half of the island, and the much higher Rakata, which still exists.

The exact time of the eruption is not known; but Capt. Hollmann of the German ship Elizabeth, which passed in front of Anjer on the morning of May 20, noticed a parasol-shaped column of smoke rising to a height of eleven thousand metres on the Perboewatan, and soon afterwards a fall of light cinders lasting several days. Up to Aug. 26, the eruptions were intermittent and somewhat light; but from this day they increased in intensity. Very violent noises were heard at the same time that a thick cloud obscured daylight. These lasted up to the morning of



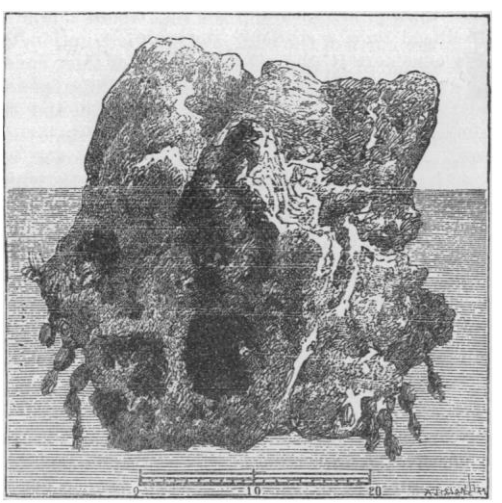
TELOK-BETOENG AFTER THE ERUPTION.

the 27th, the strongest being from five to eleven o'clock in the morning (Batavia time). The most startling were produced at ten o'clock, probably the time when the island divided. The falling in of these

huge masses of earth piled up the vast waves which swept with such destructive force upon the islands of Java and Sumatra, and destroyed forty thousand human beings. Some lesser explosions were heard during the rest of the 27th, and the day of the 28th.

Scarcely any thing is known of Krakatoa before this eruption; but there are records of a similar, though less extensive, eruption in May, 1680. For two hundred years it has fallen into an uninterrupted sleep to be awakened with such terrible violence in 1883. At the time of the eruption it was uninhabited. There are certain legends handed down by the natives of the neighboring islands from which we can see that the existence of Krakatoa as an eruptive volcano antedates Javanese heroic history.

The travellers had little difficulty in landing on the extreme west of the cliff, on the shores of a small inlet following a deep ravine newly eroded by the rain through both the light material recently ejected, and



PUMICE FOUND FLOATING FIFTEEN MILES FROM MADAGASCAR, AUG. 13, 1884 (*La nature*).

the underlying older solid lava-beds. The ashes at this place were from sixty to eighty metres in depth, and were well separated from the black and gray lava by their white color. Although more than nine months had elapsed since this matter had been thrown out, still, in some places, it was so warm that steam escaped from among the ashes, leaving a layer of sulphur and sal-ammoniac behind. A bituminous odor was also noticeable, and this was no doubt due to the dry distillation of the vegetation buried beneath the warm cinders. After taking photographs, they left the island, and proceeded toward Lang and Verlaten, two small islands, probably a part of Krakatoa torn asunder during some remote eruption. These islands, like all their neighbors, are covered with a mass of pulverized pumice thirty metres deep, furrowed by the rain. The aspect of the islands reminds one of the front of certain glaciers; but the temperature of 40° C., due to the absorption of the sun's heat, will not allow this deception to last long. The surface of these two islands is much increased by the piling up of material on their sides during the eruption. To counteract this increase of surface, an island, Poolsche Hood, which was situated to the east of Verlaten, and a reef, Polish Hat, which rose to the west of Lang, have disappeared. Save the escape of steam, mentioned above, and which is independent of volcanic activity, absolute tranquillity reigns in these desolated regions. There are neither fumeroles, nor jets of vapor under pressure, which generally persist a long time after the eruptive period. The natural equilibrium is re-established. But it is to be remembered that the fires merely sleep, and that probably some day they may awake from their lethargy.

In conclusion, it may be well to give a brief account of the geological structure of Krakatoa and the neighboring islands. The series of volcanic islands to which Krakatoa belongs, follows a line extending N.N.W., obliquely across the straits of Sunda, and forming an angle with the lines of the principal volcanoes of Java and western Sumatra. The point where these three lines meet is found approximately at Krakatoa. The base of the island is made up of solid columns of a crystalline basalt, and of augite and labradorite, all very basic, and in which pyroxine augite made an abundant part of the second consolidation. These basic formations have been found at Krakatoa, Sebuku, Protection, and Sebesie. Above these various basaltics is a compact column of andesite, becoming more and more acid in its upper part, and nearly barren of the microliths of augite which are abundant near its base. There are layers of pumice between the sheets of lava, showing that the eruptions of the volcano have been of two kinds succeeding each other.

The ashes ejected by the last eruption are composed principally of a light spongy pumice, and of irregular blocks of a compact dark glass, in which may be distinguished the brilliant crystals of labradorite. This acid glass (70-72 in a hundred parts of Si.) presents a very simple constitution. It contains a good number of crystals (first consolidation) of labradorite, augite, hypersthene, and titaniferous oxide of iron; also elements of the second consolidation in the form of felspathic microliths, attributable to oligoclase. In addition to these truly volcanic matters, we may mention some *débris* in terrains, composed of fragments of quartziferous diorite, and balls of a calciferous marl, regular, and polished by erosion with pumice. These *débris* products are relatively rare; and, to all external appearance, the islands are one mass of volcanic ash.

TOUGHENED GLASS.[1]

UPON investigating the De la Bastie invention of the so-called toughened glass, Mr. Frederick Siemens has found that the process is not a manufacturing process at all, but, rather, a somewhat impracticable

[1] Condensed from a paper read before the Society of arts, London.